MULTIMISSION HIGH SPEED SPACECRAFT SIMULATION

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Abstract

A simulation system has been developed which is capable of bit level simulation of spacecraft data systems. Object oriented techniques and an embedded interpreted language have been employed to produce a highly configurable tool for control and viewing of spacecraft states. Parallel processing computers have been used for running simulations to achieve execution performance of up to ten times real time, which allows for effective utilization of the simulator in testing spacecraft command sequences before they are committed to operation. Elements of simulations can be reused as-is in the construction of new simulators.

1. Background

Spacecraft exploration of the solar system requires communication over long distances, with communication delays on the order of hours. Commands sent to a spacecraft must meet a high standard of accuracy, as an error in a command can not be rapidly detected and corrected and could potentially mean loss of the spacecraft. Construction and verification of command sequences has traditionally been a labor intensive and painstaking procedure.

Since the advent of microprocessors in spacecraft data systems, it has been considered too complex to perform a rapid simulation of the data operations of a spacecraft bit for bit in order to test and validate planned event sequences to be carried out in space. However, advances in computing technology have provided machines with previously unimagined capabilities which have made this job feasible.

We have built a prototype multimission spacecraft simulator which has been used for the Galileo and Cassini missions to demonstrate the feasibility of bit level simulation, and are currently building a production version for each mission. The Galileo spacecraft, which incorporates a data system consisting of six RCA 1802 microprocessors running at 200 KHz and two spacecraft data buses running at 400 KHz, is now on its way to Jupiter for a two year orbital tour beginning in December 1995. The Cassini spacecraft is currently being designed and will have a data system consisting of four 1 MIP 1750a microprocessors connected by 1 MHz 1553b data buses. It will perform a similar mission at Saturn.

This paper discusses a new object-oriented architecture and implementation for bit-level simulation which gives a multi-mission modeling capability, flexible scheduling of element execution, the ability to establish hoc views of simulation components, and significantly higher levels of adaptability and maintainability.

Summary

We have delivered an initial production version of the Galileo simulator, and are currently implementing a production version of a Cassini simulator. Our current implementation already provides speed, flexibility, visibility, and ease of use advantages over the existing hardware simulator for Galileo. Further enhancements to the user interface will give visibility and control of systems that flight software developers had not previously imagined.

Further use for other missions from Voyager to MESUR is also being considered. We feel that the flexibility of this implementation will allow us to produce simulations of other spacecraft that give high capability at a relatively low cost.

Further development of the simulator into a design tool may make possible the development of new architectures for spacecraft data systems that would not otherwise be tried because of expense and risk. If so, the technology of spacecraft design could be evolved more rapidly.